

DSP: sec 5

$$X(K) = \sum_{n=0}^{N-1} x(n) e^{-j \frac{2\pi}{N} Kn}$$

Programming Assignment

Input  $x(n)$

2-weeks

output  $|X(K)|$

$$W_N = e^{-j \frac{2\pi}{N}}$$

$$X(K) = \sum_{n=0}^{N-1} x(n) W_N^{Kn}$$

EX 4-point DFT

$$X(n) = \{1, -1, 0, 1\}$$

$$\Rightarrow X(n) = \begin{bmatrix} 1 \\ -1 \\ 0 \\ 1 \end{bmatrix}$$

$$W_N = e^{-j \frac{2\pi}{N}}$$

$$W_4 = e^{-j \frac{\pi}{2}} = \cos\left(\frac{-\pi}{2}\right) + j \sin\left(\frac{-\pi}{2}\right)$$

$$= -j$$

$$W_4^{Kn} = \begin{matrix} & n=0 & n=1 & n=2 & n=3 \\ \begin{matrix} K=0 \\ K=1 \\ K=2 \\ K=3 \end{matrix} & \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \end{matrix}$$

$$j = -j^3 = j^5$$

$$j = j^5 = j^9 = \dots$$

$$j^2 = j^6 = j^{10} = \dots$$

$$X(K) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 1 \\ -1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1+2j \\ 1 \\ 1-2j \end{bmatrix}$$

$W_4^{Kn}$ 
 $X(n)$

$$|X(K)| = \{1, \sqrt{1+4}, 1, \sqrt{1+4}\}$$

$$\angle X(K) = \{0, \angle 3, 0, -\angle 3\}$$

$$\angle 3$$

# 3-point DFT

$$x(n) = \{1, 2, 1\}$$

$$W_3 = e^{-j \frac{2\pi}{3}} = \cos \frac{-2\pi}{3} + j \sin \frac{-2\pi}{3}$$

$$= \frac{-1}{2} - j \frac{\sqrt{3}}{2}$$

$$W_3 = \begin{matrix} & n=0 & n=1 & n=2 \\ \begin{matrix} K=0 \\ K=1 \\ K=2 \end{matrix} & \begin{bmatrix} 1 & 1 & 1 \\ 1 & \frac{-1}{2} - j \frac{\sqrt{3}}{2} & \left(\frac{-1}{2} - j \frac{\sqrt{3}}{2}\right)^2 \\ 1 & \left(\frac{-1}{2} - j \frac{\sqrt{3}}{2}\right)^2 & \left(\frac{-1}{2} - j \frac{\sqrt{3}}{2}\right)^4 \end{bmatrix} \end{matrix}$$

$$= \begin{bmatrix} 1 & 1 & 1 \\ 1 & \frac{-1}{2} - j \frac{\sqrt{3}}{2} & \frac{-1}{2} + j \frac{\sqrt{3}}{2} \\ 1 & \frac{-1}{2} + j \frac{\sqrt{3}}{2} & \frac{-1}{2} - j \frac{\sqrt{3}}{2} \end{bmatrix}$$

$$X(K) = \begin{bmatrix} 1 & 1 & 1 \\ 1 & \frac{-1}{2} - j \frac{\sqrt{3}}{2} & \frac{-1}{2} + j \frac{\sqrt{3}}{2} \\ 1 & \frac{-1}{2} + j \frac{\sqrt{3}}{2} & \frac{-1}{2} - j \frac{\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}$$

$$X(K) = \begin{bmatrix} 4 \\ \frac{-1}{2} - j\frac{\sqrt{3}}{2} \\ \frac{-1}{2} + j\frac{\sqrt{3}}{2} \end{bmatrix}$$

$$|X(K)| = \sim$$

$$\angle X(K) \sim \sim$$

.....

### \* 3-point DFT

$$x(n) = \{-1, 1\}$$

Sol

$$x(n) = \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix}$$

$$W_3 = e^{-j \frac{2\pi}{3}} = \cos \frac{-2\pi}{3} + j \sin \frac{-2\pi}{3}$$

$$\cancel{e^{-j \frac{2\pi}{3}}} = -\frac{1}{2} - j \frac{\sqrt{3}}{2}$$

$$W_3^{kn} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & W_3^1 & W_3^2 \\ 1 & W_3^2 & W_3^4 \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & \frac{-1}{2} - j \frac{\sqrt{3}}{2} & \frac{-1}{2} + j \frac{\sqrt{3}}{2} \\ 1 & \frac{-1}{2} + j \frac{\sqrt{3}}{2} & \frac{-1}{2} - j \frac{\sqrt{3}}{2} \end{bmatrix}$$

$$X(K) = W_3^{kn} * x(n)$$

\* 4-point  $x(n) = \{1, 2, 1, 2\}$

Report  $\rightarrow$  Every team

• DSP موضوع يستخدم فيه ال

$\rightarrow$  slides

• "سلايد"  $\rightarrow$  "موضوع" مثل

\* Application depends on DSP

\* General ~~phases~~ in the application (system)  
Blocks

• determine whether these blocks  
depends on DSP

